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EDITORIAL NOTES

FUEL FOR THE POST-WAR HOUSE

WITH a pretty jacket there has just been published another report on heating, cooking, and hot water supplies for the post-war house. This is a summary of the views of the Women's Advisory Committee on Solid Fuel, which Committee was formed in March of last year at the request of the Domestic Fuels and Appliances Committee of the coal industry. The ladies of the Committee obviously set to work with a will, meeting experts on the subject, visiting collieries and carbonization plants and the factories of appliance makers; this coupled with a study of previous reports, which study, considering the number of the reports already issued, must have taken more than half an hour. Sixteen organizations were represented on the Committee, including the Federation of Soroptimists' Clubs of Great Britain and Ireland, the National Union of Domestic Workers, and the Women's Publicity Planning Association. There were also "individual members," among them a Press agent. The report contains a number of appendices. One of them gives estimates of population from 1935 to 2035. On the assumption that both fertility and mortality continue to fall at a rate deduced from recent trends, it is estimated that by 2035 the population of England and Wales will have shrunk to 4½ millions and of Scotland to less than a million. On which assumption the fuel problem will be somewhat changed.

We are more concerned, however, with planning rather less remote than for 2035 *et seq*. One of the tables shows the relationship between the time saved by reducing labour and the money paid to charwomen in London and the Provinces. A saving of 20 minutes a day, for example, means a saving per year in London of £7 11s. 3d. On this basis the cost of gas on a two-part tariff (x – £7 11s. 3d.) would not be much of a financial burden. A few more minutes saved, and we shall obviously be in pocket. Appendix XII discusses the importance of the use of raw coal in supplying domestic heat. Coal, it is stated, "provides climate compensation (heat, light, and ventilation), nutrition (cooking and refrigeration), hygiene (hot water, drying and airing of clothes), and amenities (ironing, vacuum cleaning, radio, &c.). This coal is either burned directly—in the raw state or after conversion into smokeless solid fuels—or is used for the production of gas and electricity. . . . The only practical ways to smoke abatement are either to use smokeless fuels or to develop methods of burning bituminous coal so as to produce little smoke." We think there will be little argument about the validity of this conclusion.

The ladies concerned attach the greatest possible importance to smoke abatement and the reduction of atmospheric pollution. Their visits to gas-works have impressed them, and have led them to hope that smokeless fuels will become available in greater quantities in the future. But they think it will be many years before the possibility of abolishing the use of raw coal can be seriously considered. "On account of its cheapness (*sic*) and the fact that it can be stored to meet sudden demands for heat during the winter cold spells coal has advantages which cannot be ignored." Hence "every effort should be made to provide more convenient and efficient coal-using appliances." Of course, contentions about cheapness and the storage factor apply equally to coke, which is smokeless. As we have indicated, the ladies have studied hard, and they have been unafraid in tackling economic and technical problems. They point out that the price of coal for making gas and electricity is already rising, and go on to say that this "is likely to continue to do so if miners are to be provided with adequate remuneration." Which statement is followed immediately by the comment that if the house coal market, from which the bulk of the cost of coal production is at present obtained, were appreciably decreased, it would be necessary to increase the prices of coal for making gas and electricity to a point at which the cost of these fuels to the consumer might well become prohibitive. "It is therefore necessary, for both practical and economic reasons, to look to raw coal to supply a high proportion of domestic heating services for many years to come." It is recommended that schemes for district heating should be tried out experimentally, and reference is made to two small housing estates served by district heating by the Dundee Corporation—a scheme which involves the Dundee Town Council in a financial loss.

We may summarize the general conclusions reached by the Committee. First there is a general demand for a positive policy in dealing with official reports and with private reports, such as the one under review. Authorities responsible for housing and reconstruction generally should take account of the changing attitude of women towards household drudgery. There is a need to foster in all branches of industry a new attitude towards national duty. Notwithstanding the desire of women for improved household amenities, there is widespread ignorance of what is possible. Unless this is removed there may be resistance to change, even for the better. The education of the public in the better use of fuel, which has been undertaken as a wartime measure, should be continued and extended after the war. In the interests of coal conservation and national economy, competition between the fuel and power industries should be replaced by planned co-operation, provided such collaboration is also in the interests of the consumer.

The report costs 1s. 3d. a copy, and is obtainable from the address of B.C.U.R.A. at 4, Rickett Street, Fulham, S.W. 6.

INSTITUTE OF FUEL

THE need for men trained in fuel technology is very great, and it is considered that this will be much greater in the post-war period. Especial interest therefore attaches to a general statement by the Institute of Fuel on its education scheme. The statement was published in the August issue of the Institute's *Journal*. The scheme is based broadly on the notion that a fuel technologist is a qualified engineer, chemist, or chemical engineer who has acquired a special knowledge of fuels and their production and utilization and is competent to apply his knowledge. The approach to fuel technology may therefore be taken from the chemical or from the engineering sides, but if it is taken from the engineering side an adequate knowledge of chemistry is regarded as essential.

In regard to the Associate Membership Examination the view is taken that, although it is not practicable to inaugurate a National Certificate Scheme in fuel technology, use should be made of existing National Certificate Schemes in mechanical engineering, electrical engineering, and chemistry, and that the Ordinary National Certificates should be accepted as satisfying part of the requirements. For the other part of the requirements a special syllabus in physics and chemistry has been drawn up. For both sections the City and Guilds of London Institute has been asked to conduct the examinations, and an Exploratory Committee representative of the various fuel interests has been set up. In addition to passing the examinations in both sections, a candidate for Associate Membership of the Institute is required to be not less than 25 years of age, and

to satisfy the Council that he has undergone two years' training and one year's practical experience involving some recognized branch of fuel technology.

The strength of the Institute and the value of its work have increased considerably during the war years, and its new education scheme bids fair to enhance its status and bring added point to its proceedings.

Obituary

The death has occurred of Mr. WALTER R. HAWKINS, who was associated with Cannon Iron Foundries, Ltd., for 60 years, and who for many years was General Manager of the Gas Stove Department.

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Page 129. BOMBAY. L. W. Boulter, *G. M. & E., vice* W. T. Lane, resigned.

Diary

Sept. 8.—North British Association of Gas Managers: Annual Meeting, Edinburgh.
Sept. 12.—N.G.C. Central Executive Board, Lord Mayor of Leicester's Rooms at Hastings Street, Leicester, 1.30 p.m.
Sept. 12.—B.G.F. Council, Leicester, following meeting of N.G.C. C.E.B.
Sept. 18.—London and Counties Coke Association: Finance Committee 11 a.m., Executive Committee 11.30 a.m., Central Committee 1.30 p.m., Gas Industry House.
Sept. 28.—Wales and Monmouthshire Association of Gas Engineers and Managers: General Meeting, Institute of Engineers, Park Place, Cardiff, 11 a.m.
Oct. 11.—Southern Association of Gas Engineers and Managers: General Committee, 11.30 a.m.; Autumn Meeting, 2.30 p.m.; Grosvenor House, Park Lane, London.
Oct. 27.—Manchester District Association of Gas Engineers: Autumn General Meeting.

Dividend

Gas Consolidation, Ltd.—2½% on the "A" Ordinary Stock, less tax, making, with the interim dividend already paid, 5% p.a. On the "B" Ordinary Stock 3%, less tax, making, with the interim dividend, 5% p.a.

A 100% Primary Air Burner

The development of a 100% primary air burner at the Testing Laboratories of the American Gas Association is referred to as outstanding by Mr. R. M. Conner, Director of the Laboratories, in the July–August issue of the A.G.A. *Monthly*. He says: "I do not propose to coin a popular name for it, but I often think of it as the 'Brighter Bunsen.' For although its flame is radically different, it is still a bunsen burner in principle. Symbolically as well as literally it burns brighter—sharp and hard and blue. Its development has progressed sufficiently far so that it may now be said that the guiding light of Gas Industry research burns with a new brilliance, and that its rays may reveal many worth-while developments yet to come.

"The flame of the all-primary air-burner is radically different from that of a conventional type. First of all it is considerably shorter, consisting of a single cone upon the surface of which complete combustion takes place. Hence the usual secondary combustion zone or outer mantle of the bunsen flame is completely absent. This characteristic eliminates many design problems encountered, especially on ranges, in supplying sufficient secondary air to the flame for complete combustion. Aeration bowls, port arrangement for adequate secondary air, blanketing effects of recirculated combustion products, and impingement—problems of contemporary design—have no counterpart in burners utilizing all primary air. They will burn town gas completely in the products of their own combustion.

"These characteristics when properly harnessed for domestic application readily suggest many improvements in contemporary appliances. Concrete applications should come many times faster than parallel developments in conventional types. The extent of possibilities which can reasonably be foreseen at this time depends on the development of practical models of experimental burners so far available. Generally speaking elimination of secondary air inlets and substantial reduction in combustion space means more compact equipment. Short, sharp, and efficient single cone flames should further advance compactness and lead to greater heating speeds and efficiencies. Overall improvement in thermal control, heat transfer rates, efficiency, and appearance can be expected to accompany general use of 100% primary air burners.

"Translated into specific applications, a new freedom of design can be discerned. It probably will emerge as the emancipator of the gas range from sundry trappings which stand in the way of smooth top styling. Little clearance or venting height is required. Grates may conceivably be constructed flush or eliminated by incorporation into burner design. Higher oven preheating speeds and griller temperatures should prove more practical. Redesign of size and placement of oven and broiler burners likewise seems probable, resulting in better heat distribution and more usable space.

"Similarly in water heaters, furnaces, and space heaters many of the same potentialities apply. Elimination of large quantities of excess air to ensure complete secondary combustion should lead to higher efficiencies. The cooling effect of strong stack action to handle this excess air can be overcome while greater baffling becomes possible.

"Further research on the new type burner is proceeding at an accelerated pace."

Ayrshire Gas Supply

At the request of Ayr County Council, Mr. J. R. Lockie, County Clerk, recently prepared a memorandum dealing with the gas supply in Ayrshire, setting forth the views of the British Gas Federation and other bodies on the Industry. In his memorandum he stated that there were six local authorities in the County supplying gas and 22 private undertakings, prices varying from 3s. 4d. per 1,000 cu.ft. in Ayr to 8s. 4d. in Mauchline.

A Committee of Ayr County Council afterwards considered the memorandum, and recommended that any legislation introduced should provide for the ownership and administration of all gas supply undertakings in the County by the County Council, this body representing large and small burghs and the landward areas. An amendment, which failed, proposed what was virtually nationalization of the Industry and administration by regional committees, the latter to be formed by representatives of the local authorities.

At a meeting of the landward area representatives at Ayr on Aug. 29, the Earl of Glasgow presiding, the Committee's recommendation was approved by 14 votes to 13, a proposal to remit back being defeated by 18 votes to 7.

Science in the Universities

In a report on "Science in the Universities" submitted by the Association of Scientific Workers to the University Grants Committee of the Treasury it is recommended that professors should have a graduate assistant to relieve them of administrative routine. Much more attention needs to be given to the technique of teaching, and informal instruction should be given to young lecturers. Teaching ability should be given more weight in making appointments. The Universities' Superannuation System should be extended, to encourage mobility of scientists between all types of laboratory.

All graduates with an aptitude for research should be offered full maintenance while working for a higher degree. It is proposed that 250 research studentships of this nature be awarded in the first year after the war, rising to 500 per year after five years; the value to be £250 p.a., at 1939 values. Research Fellowships, for those who have taken a doctorate, should also be instituted at a value of £500 p.a. and eventually to the number of about 100.

Industrial development work, it is suggested, should not be carried on in academic laboratories; exceptionally, special problems should be referred to them through the relevant research association. Academic scientists should be allowed to act as consultants, or advisory directors of research, to research associations, and should be given leave to spend Long Vacations in these or in industrial laboratories.

Industrial donations should generally go to existing university funds and not to special purposes; in any case full disposal of such monies must be in academic hands.

The Ministry of Works has issued a pamphlet, "Programme and Progress" (H.M.S.O., 9d.), describing a method of programming civil engineering and heavy construction jobs at the start and of subsequently "progressing" the programme. The importance of a considered programme is emphasized. Unless the sequence of events in a contract is carefully thought out, and dovetailed together, at the very beginning, time and money will inevitably be lost. The meaning of programming and progressing is explained, and simple illustrations show how a programme chart is prepared, and how such a chart enables the programme to be easily adjusted to meet any unexpected contingencies that may arise. Although the pamphlet does not do more than codify what is the best practice and experience, it is nevertheless an important document.

The fact that goods made of raw materials in short supply owing to war conditions are advertised in the "Journal" should not be taken as an indication that they are necessarily available for export.

Industrial Application of Infra-Red (Radiant Heat)*

By A. C. F. MACKADAM

A GREAT deal of publicity has lately been given to industrial infra-red heating by electric radiant lamps, but it is not generally known that for many years intensive research and development of infra-red heating has been carried out and successfully applied by the Gas Industry.

The chief application of infra-red rays at the present time is for paint-drying, and the Author proposes to deal briefly with this process, with electricity and gas as the two sources of heat. In this connexion we are concerned with two methods of heat transmission—*i.e.*, radiation and convection. Radiant heat (infra-red) is emitted from the heating element in the form of heat rays, which, passing through the air, are absorbed by surrounding objects in its direct path.

Convection heat is absorbed by the air passing over the heating element and, in turn, is imparted to surrounding objects until they attain the temperature of the air.

With the introduction of synthetic-resin enamels and paint finishes capable of very rapid drying, infra-red radiant heating has been adopted, with gas or electricity as the source of heat. For many years the drying of paint-finishes on metal and other processes was carried out in what are called convector ovens by heating the air in the ovens or by passing heated air through the same (forced convection).

When considering infra-red sources it should be remembered that infra-red heating is not new, and that in a convector oven a large proportion of the heat transferred to the load is often by infra-red rays; in fact, the widespread use of convector ovens makes it necessary to give some analysis of the relative merits of both convection and radiant heating. It is true that many processes now carried out in convector ovens can be more quickly and easily performed by infra-red treatment, but equally true that for others convector heating must remain. Research on infra-red, as a matter of fact, has indicated methods of improving convector oven practice.

It is not generally recognized that in a convector oven a major portion of the heat transfer may take place by radiation. Taking, as an example, a metal sheet suspended in a convector oven so that it is under direct radiation from the heating elements—*i.e.*, not shielded by another sheet—the following figures indicate the relative influence of radiation and convection on heat transfer for a plate being heated from 50° to 220°F.:

Oven temperature, °F.		250.	300.	400.	500.	600.
Natural convection	Radiation %	64.5	65.3	68.2	72.2	76.0
	Convection %	35.5	34.7	31.8	27.8	24.0
Forced convection 5 ft. per sec.	Radiation %	47.7	48.1	49.0	52.0	57.4
	Convection %	52.3	51.9	51.0	48.0	42.6

For paint-drying it has not been usual to operate with oven temperature exceeding 350°F. It will be obvious that the oven temperature must not exceed the spoiling temperature of the paint (this is frequently within 50°F. of the drying temperature). Articles in sight of the walls are heated by radiation and by convection when shielded from the walls, the articles in sight of the walls becoming heated more rapidly. Hence, articles nearest the walls may be burned, whilst the work in the centre of the oven may not be dried. This defect in the batch type oven is partially overcome by the forced convection oven as the walls are well insulated to prevent heat losses and will only reach the temperature of the circulating air. If, however, the convector oven can be used so that articles passing through it are not shielded from direct radiation from the walls, the conveyor system can be accelerated so that the objects do not exceed the maximum safe temperature and greatly increased rates of heating can be achieved; in fact the conveyor oven has become an infra-red oven with the added advantage of convected heat transfer. The limiting factor, however, is the maximum temperature at which such an oven can be operated economically.

It is doubtful, however, if this maximum is above 400°F., even with the best type of convector oven.

The following figures indicate the time taken for plates of various thicknesses to reach 220°F. in a convector oven at temperatures from 250° to 400°F., when in full view of the walls, and when shielded; and in two types of gas-fired infra-red tunnel:

Gauge No. s.w.g.	Thickness.	Time in minutes. Oven temperature, °F. 250. Exposed.	250. Shielded.	300. Exposed.	300. Shielded.	400. Exposed.	400. Shielded.	Infra-red tunnel. °F. 650.	Infra-red tunnel. °F. 1,600.
22	0.031	2.4	6.8	1.4	3.8	0.8	2.2	0.7	—
16	0.062	4.7	13.3	2.8	7.6	1.5	4.4	1.25	—
14	0.078	5.9	16.7	3.6	9.8	1.9	5.6	1.5	—
12	0.099	7.4	21.0	4.5	12.3	2.5	7.2	1.9	—
10	0.125	9.3	26.3	5.6	15.3	3.1	9.0	2.5	—
4	0.25	18.6	52.6	11.2	30.5	6.2	18.0	5.0	0.25
—	0.50	37.2	105.0	22.4	61.2	12.3	35.7	10.6	0.50

* From a Paper to the Junior Institution of Engineers, published in the July issue of the Institution's *Journal*.

It will be seen from these figures that for the infra-red tunnel precise timing is very important, for if the heating period is extended the paint will be spoiled. The amazingly short times obtained with the high temperature panel make its use difficult for paint drying except on heavy objects.

It may be mentioned that with both the medium temperature and the high temperature infra-red tunnels the temperature of the air in the tunnel is only about 25°F. above atmospheric temperature.

The advantages of infra-red drying are most marked when large numbers of the same object have to be treated, and where each article can pass through the oven without being shadowed by its neighbours from the direct path of the heat rays in the tunnel. Simple shapes with approximately the same surface to weight ratio are easiest to process, and articles with re-entrant angles require special care so that the heating of the shadowed portions by conduction will proceed at approximately the same rate as parts directly exposed to direct heat rays.

Practical Sources of Infra-Red Rays

It should be clear from what has already been said that infra-red rays are simply radiant heat, and all the familiar radiant heaters, such as gas fires, gas grills, electric fires, electric bulbs, &c., emit nearly all their heat energy in the infra-red region.

The practical problem is to produce radiant heat economically with a suitable and reasonably uniform intensity over the whole surface of the object to be heated; to ensure it being substantially absorbed by the surface on which it falls.

Suitable Intensities of Radiation

It has been common practice in electric infra-red paint-drying to obtain a heat density of the order of 3 to 6 watts per sq. in. falling on the working plane—*i.e.*, on each side of a metal sheet. The equivalent in terms of units normally used by the Gas Industry is 1 watt per sq. in.—490 B.Th.U. per sq. ft. per hour, and therefore a total heat density of the order of 750 to 1,500 B.Th.U. per hour is likely to be suitable for many paint-drying purposes, and this has been proved in practice for dealing with sheet metal objects. Much higher intensities are, however, needed for the heating of heavy objects and, with gas as the source of heat, it is possible to go as high as 100 watts per sq. in. or about 50,000 B.Th.U. per sq. ft. per hour.

The most suitable heat density is determined primarily by the rate of heating-up required, and for many processes the ultimate temperature reached by the object is unimportant, as it is removed from the source of heat long before this temperature is reached. The ultimate temperature obviously cannot exceed the temperature of the surrounding heat sources, and normally the object will be at a substantially lower temperature due to convected heat losses.

For certain types of work where the objects may be irregular in shape and thickness, and where there is little margin between the drying temperature and the spoiling temperature of the paint, it may be desirable to take advantage of a variation in radiation intensity over different parts of the object, or it may be necessary to produce a high overall radiant intensity for heating up and a lower radiant intensity to maintain a temperature obtained quickly by the high intensity. This can be achieved in the electric type of unit by adjustment of the reflectors and spacing of the small units or by adjusting the gas flow rate on a gas-fired unit. The advantage of the gas-fired unit is that a very wide range of temperatures can be obtained by a simple adjustment of the gas flow, while maintaining an even distribution of heat over the whole surface of the emittor.

For gas-heated sources practical experience has shown that a unit with large radiating surfaces of two semi-circular sections facing each other having a radius of 16 in. gave excellent results on thin metal sheets 2 ft. sq., on metal cans 2 ft. high, 1 ft. 6 in. wide, and 6 ft. deep, and on heavy tapered castings of cylindrical shape, 1 ft. in length and a maximum diameter of 4 in.

The outstanding difference between the high temperature electric sources and the gas medium temperature "black emittor" is the wavelength of the infra-red rays developed. The wave band of the former is from 7,700 A.U. to 40,000 A.U., with a peak at 12,000 A.U., while the gas panel radiation extends from 15,000 A.U. to 180,000 A.U., with an extended peak between 40,000 to 60,000 A.U. The practical significance of this difference is that the drying time of different colours in a gas-fired panel unit is not affected to the same extent as in the electric panel unit. For example, at the same radiant intensity, the time taken for a black plate and a white plate to reach 300°F. in a "black emittor" gas panel was 150 and 170 seconds respectively, while the same plates in an electric tunnel took 150 and 270 seconds respectively.

Below are given two examples of the heat transfer to a plate, 1 ft. sq. (surface area 2 sq. ft.), raised from 60 to 220°F. and 300°F. respectively:

Oven temperature, °F.	250.	300.	400.	500.	600.
Plate heated to 220° F.					
Convected heat transfer B.Th.U./hour	220	365	628	890	1,145
Radiant heat transfer B.Th.U/hour	440	685	1,345	2,285	3,580
Total B.Th.U./hour	660	1,050	1,973	3,175	4,725
Plate heated to 300°F.					
Oven temperature, Fahrenheit	350	400	500	600	—
Convected heat transfer B.Th.U./hour	450	490	763	1,018	—
Radiant heat transfer B.Th.U./hour	946	1,275	2,200	3,492	—
Total B.Th.U./hour	1,396	1,765	2,963	4,510	—

The following notes were received from Mr. **W. Dieterichs,** Gas Light and Coke Company:

I was particularly interested in the reference to the normal type of gas-heated convector oven. I can remember so well that when infra-red for industrial purposes became more popular a year or so ago, many firms were under the impression that infra-red was something quite different from radiant heat, but I think this has been finally cleared up. The standard convector oven, as the Author quite rightly points out, does give a very high percentage of radiant heat, and if it were used in the same way as an electric or gas infra-red tunnel, the same results would be obtained. The only difficulty is that many of the convector ovens are not designed to give a very high surface temperature on the inner sheets and therefore its use is limited. The question of screening would be the chief difficulty if the inner sheets or lining could be raised to the desired temperature.

Infra-red within the last few years has received a considerable amount of publicity, and I am sorry to say that all kinds of misstatements have been made, not by scientists or engineers, but chiefly by commercial people attempting to market appliances which they do not thoroughly understand. No doubt many of you remember an article which appeared in a Government bulletin stating that infra-red was being used to heat bearings which were enclosed in grease-proof paper and in a cardboard box, which gave the impression that infra-red rays would penetrate cardboard, whereas most of us know that even a thin sheet of paper would absorb all the infra-red rays. There are certain materials, such as rock salt, which are transparent to infra-red, but there are very few materials which could be used for such a purpose as packing.

In 1905 Coblentz did a vast amount of work in America on this subject, and later papers have been given by Maxted, Andrew and Chamberlain, and quite recently by Reavell, all of which contain most valuable information, and engineers interested will find them well worth reading. I am suggesting this because I feel sure that the use of radiant heat for industrial purposes, whether by electricity, gas, steam, high pressure hot water or some of the high temperature circulating fluids, will receive much more serious consideration than it has done in the past.

I almost hesitate to refer to wave-lengths, but there is no doubt that a lot more work will have to be done; in fact we are already finding that statements made a few months ago regarding certain processes being unsuitable for infra-red treatment have had to be reversed; for example, core drying. There was a general impression that radiant heat for this process was quite unsuitable, but it has been found that if the right wave-length is selected the job can be done quite satisfactorily. What I mean is that if you were to use the electric infra-red lamp which gives a wave-length of between 10,000 and 15,000, the penetration is not as deep as if you use the black emittor having a surface temperature of 800°F., and this will apply to many other materials.

Generally speaking, the use of infra-red has been largely confined to paint-drying, and whilst I am on this point I would like to say that I am a little nervous, and I sometimes wonder whether paints dried in so short a time will have the same durability as paint dried a little more slowly. I do not mean, of course, extending the time from minutes to hours, but we have found that we can dry certain paints using the high intensity panel which has a wave-length of between 20,000 and 25,000 in a few seconds, whereas when using the low intensity panel having a temperature of, say, 650°F., and a wave-length of 45,000 to 50,000, the time required for drying is, say, 2 minutes. This, however, is a matter for the paint manufacturers, and no doubt they are giving the matter the attention which I think it deserves.

No doubt some of you may be wondering how the costs compare. I have been fortunate in obtaining some costs from a firm where they have an electric and a gas tunnel installed, both doing the same work and having the same output. These figures have been sent to me by a firm having no interest in either gas or electricity and I think you will find them interesting:

	Radiant heat.	
	Electricity.	Gas.
Plant cost per foot of installation	£60	£15
Energy consumption per foot per hour	3 Kw.	54 cu.ft.
Energy cost per foot per hour	1.8d.	1.33d.
Time of radiation—minutes	6.6	1.7
Length of heating zone—ft.	32	9
Fuel consumption per hour	96 Kw.	480 cu.ft.
Fuel cost for baking 600 articles per hour	4s. 9d.	1s.

Vapour Phase Gum Research*

By H. D. LEHMAN,

Chairman, A.G.A. Gas Conditioning Committee

ON May 8, 1944, a proposed requirement was issued to the Industry by the A.G.A. Approval Requirements Committee calling for the installation of protective devices on pilots for appliances to be used on manufactured gas for protection against vapour phase gum deposition. This requirement will make effective the recommendation of the Gas Conditioning Committee dated Dec. 8, 1939. Barring the unforeseen, and allowing for the period customary for criticism and to permit manufacturers to make necessary arrangements to carry out the requirement, this basic requirement should become effective by the end of 1945.

Problem in Manufactured Gas

Perhaps this is an appropriate time to review briefly something of the vapour phase gum problem in manufactured gas. First of all, there is some reason, and perhaps pretty good reason, to believe that vapour phase gum has always existed in manufacturered gas, and that it was the use of automatic equipment for fuel purposes that caused the problem to assert itself originally and to press its importance increasingly upon the Industry in recent years.

From the standpoint of fuel uses, the existence of the problem was established as long ago as 1930, when, in at least one rather large situation, gas refrigerators showed an annoying genius for failing to function, as the result of the deposition of a dark substance on the adjusting needle. With the passage of time, of course, the existence of this substance was established on other automatic equipment and in other properties until its prevalence has been generally recognized.

Almost immediately after the existence of the problem was established, work was undertaken to determine the nature of the substance causing the trouble and the mechanics of its formation. As is generally known, a great deal of work was done for this purpose, and, among others, Jordan, Ward, and Fulweiler, as reported in *Industrial and Engineering Chemistry*, 26,947 (1934), determined that the substance was a gummy material deposited from the gas. It was also established that its formation resulted from the now well-known interaction of the gaseous compounds NO, O_2, and unsaturated hydrocarbons. (Hence, its common description as vapour phase gum.)

Early Discoveries of Characteristics

It was established early that two of the characteristics of the gummy particles so formed were their minute size and astronomical number. Their size varied from molecular up to approximately 0.00008 in., and their number has been estimated, in an average condition, as ranging from 20,000 to 100,000 per c.c., or a maximum of nearly 3,000,000,000 per cu.ft. in an ordinary gas, giving objectionable but not excessive gum trouble. As is now well known, it was determined that, because of the small size of these particles, they had the property of remaining suspended in moving gas for an indefinite period, with the result that, once having formed, they would be certain to go throughout the entire system and be in a position to affect any piece of automatic equipment anywhere on the lines. Despite their minute size, their great number, combined with the extremely small annular openings (estimated in some cases as 0.00028 in., assuming the annulus is truly concentric) of pilot adjustment devices, results in an amount of difficulty that is, from the customer's standpoint, insupportable. In passing, it has been estimated that about three months would be required for the particles to drop by gravity through a height of 100 ft. in perfectly still gas. This simply, of course, illustrates the complete hopelessness of expecting this material to deposit out in main systems.

Work done by various sources, including the Koppers Co. and Jordan, Ward, and Fulweiler, indicated that it was possible to remove in the plant a substantial proportion of the NO, thus reducing the amount of vapour phase gum formed, but dust and other suspended matter in the gas, including vapour phase gum remaining after treatment, still cause trouble with automatic equipment. The two general methods for, as Dashiell has termed it, "eliminating the gross condition in the plant" are : (1) The use of an electric gum treater ; and (2) manipulation of the purification boxes so as to have a certain amount of iron sulphide available, which reacts with and extracts a substantial portion of the NO.

A.G.A. Laboratory Studies and Reports

The Gas Conditioning Committee to-day is, and from the very first was, convinced that, under any known method, it was impossible to eliminate all or enough of the difficulty in the plant. Further, since in the Committee's judgment there seems to be no likelihood of anything being developed to control the problem sufficiently in the plant, it became necessary to devise means of protecting the small flows which control the automatic equipment. This led to considerable development work and the use of such devices as the thin plate orifice

* From a Report presented to the American Gas Association, Technical Section, Joint Production and Chemical Committee Conference, New York.

and filter ; there are at least two of the latter which will remove effectively vapour phase gum. Because these devises had established their practicability and effectiveness, the Gas Conditioning Committee, on Dec. 8, 1939, adopted a resolution, recommending the mandatory use on A.G.A.-approved equipment of proper protective devices.

On Oct. 22, 1941, the Approval Requirements Committee instructed the A.G.A. Laboratories to do the necessary work to make possible the writing of a requirement calling for their mandatory use. This the laboratories did, under the guidance of R. M. Conner, Director of the A.G.A. Testing Laboratories, and a progress report was made at this meeting one year ago by the Supervisor of Laboratories, F. E. Vandaveer, and a final report issued in September, 1943. The work done by the laboratories, under Mr. Conner's direction, represents a first-rate job, and one for which they are entitled to substantial credit.

The A.G.A. Approval Requirements Committee, on Oct. 25, 1943, adopted a requirement calling for the use of protective devices on pilots and small flows for appliances to be used on manufactured gas for protection against vapour phase gum deposition. The specific wording of the requirement was delegated to a subcommittee subsequently appointed.

Satisfactory handling of the vapour phase gum problem would then seem to call fairly clearly for elimination of gross conditions in the plant by appropriate NO control methods (this should insure for proper protective devices a life greater than that of the average appliance) and the general use of a proper protective device.

In conclusion many have felt for a considerable period that it was not too much to say that the very stability of the manufactured gas industry depended on the stability of the pilots and small flows on automatic equipment. With this view in mind, and assuming that the above requirement becomes effective in 1945, it seems fair to assume that a basic problem of the manufactured gas industry has been finally solved, and that the Gas Conditioning Committee can consider that this one of its three major subjects has been finished.

Manchester District Association

(*Continued from p. 274*)

Radiant Heating

By Dr. A. L. Roberts,
Lecturer in Refractory Materials, University of Leeds.

Although its general principles have been well understood for a long time, the subject of radiant heating has attracted additional attention during recent years because of spectacular results which have been achieved in novel applications. An outstanding example is the application of heating by radiation to the curing of paints, varnishes, or lacquer coatings on thin metal surfaces.

The term "radiant heating" applies to processes in which the heat is transferred directly as heat waves from a hot source to the material being heated, the atmosphere between the source and irradiated material playing little or no part in the heat transfer. In heating by convection, however, the role of the atmosphere is important, as the heat transfer is effected principally *via* the air or gases circulating between the hot source and the material to be heated. It should, however, be pointed out that in many of the so-called convectional ovens and driers the proportion of heat transferred by radiation is frequently considerable.

The most important difference between radiation and convection heating is that in the former case the rate of heat transfer is dependent on the difference of the fourth powers of the temperature of the source and of the body being heated, whereas in the latter case it is broadly approximately proportional to the temperature difference.

The significance of this difference is illustrated by fig. 1, which shows approximately the total rate of heat loss from a body of high emission coefficient (0.9) at various temperatures, to its surroundings at room temperature, together with the separate components due to radiation and natural convection. It will be seen that at temperatures above approximately 300°F. the heat loss by radiation appreciably exceeds that by convection, and as the temperature rises the radiation increases much more rapidly than the convection component, becoming, for example, about four times greater at 1,000°F. At higher temperatures the difference rapidly becomes more marked. Similar considerations apply to the rate of heat transfer to a cold body by radiation from a hot source, or by convection from the surrounding hot air or products of combustion. Where the source temperature is high, the rate of transfer by radiation greatly exceeds that by convection from gases at the same temperature. Whilst the transfer by convection can be materially increased by using forced circulation, the gas velocities required if the convection is to approach the radiation transfer may well be beyond attainment in practice.

Radiant heating is well established in the Gas Industry and many familiar appliances make full use of the principle—*e.g.*, radiant panels and surface combustion units for space heating, and gas fires in which a large proportion of the potential heat in the gas is converted into radiant energy by flame impact on the refractory radiants. In gas-fired furnaces heat transfer by radiation plays a major part.

The success achieved in paint drying has, however, focused attention on the possible application of radiant heating to new and wider fields. In this particular application, the high rate of heat transfer associated with radiant heat is turned to special advantage; for instance, the time of curing of certain types of paint is reduced to a matter of minutes from a matter of hours by ordinary stoving methods. It should be realized that the remarkable results obtained are due not only to the use of radiant heating, but also to the concurrent development of paints specially suitable for treatment by radiation. The electrical industry has been largely responsible for this development, which has come to be known as the *infra-red* process. The term "infra-red" is unfortunate,

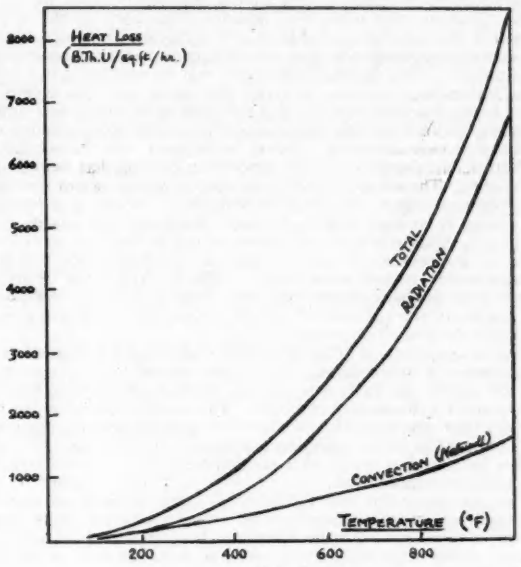


FIG. 1.

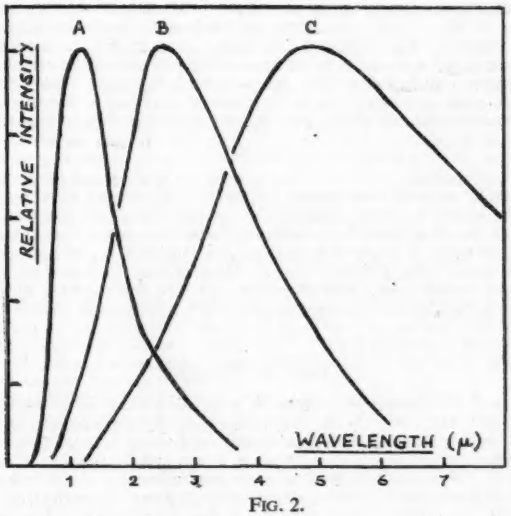


FIG. 2.

and has given rise to many misconceptions about the subject. It is really another term for heat radiation, and the process is an application of the well-known principle. No one, however, could dispute the remarkable results achieved in recent applications of radiant heating.

All objects emit "infra-red" radiation or heat rays which lie beyond the red end of the visible spectrum. The heat waves emitted from gas-heated sources such as radiant panels, surface combustion units, &c., are just as much "infra-red" as the waves from an electric tungsten-filament lamp or electric radiator. Some consideration has to be given, however, to the wave-length of the radiation from these different sources. The wave-length of the radiation emitted by a hot body depends fundamentally upon its temperature ; the higher the temperature the shorter the wave-length corresponding to the maximum intensity of radiation. This is illustrated by fig. 2, which shows approximately how the energy emitted from hot sources at different temperatures is distributed with respect to wave-length. For con-

venience it is assumed that the maximum intensity of emission is the same for each source. Curve A represents the emission from a source such as the electrical "infra-red" (tungsten-filament) lamp, which operates at 2,500°K. (4,000°F. approx.). Here the maximum intensity occurs at a wave-length of 1.2μ ($\mu = 10^{-4}$ cm.), and most of the radiation is confined between the limits of ordinary light and about 4μ. Curve B represents the distribution of energy for sources operating at about 1173°K. (1650°F), such as surface-combustion units, gas-fires, and electrical radiators. In this case the peak emission lies at about 2.5μ, and the energy is distributed well into the longer infra-red wave-lengths. Dull emitter sources such as medium temperature gas-heated panel units operate at still lower temperatures (*e.g.* 660°F.), and the emission occurs at correspondingly longer wave-lengths still (Curve C).

Fig. 2 shows that while the radiation from each of the sources named is the same in the sense that it consists of infra-red or heat waves, there are certain characteristic differences as regards wave-length distribution. How far these differences may be significant in practice is an interesting question. In paint drying, for example, claims are being made that short wave-length radiation is advantageous because it penetrates the paint film and in doing so is absorbed gradually, thus effecting uniform heating. Some substances are known to be "selective" with respect to their absorption of radiation falling upon them—*i.e.*, they will absorb energy in certain regions of the spectrum, while transmitting or reflecting the remainder. When such materials are treated by radiant heating, it seems likely that advantages might result as regards efficiency and speed of the process, or quality and finish of the product, by using a source whose radiation was most appropriate as regards wave-length to the material being irradiated. There is no doubt, however, that in a large number of applications the quality of the radiation does not matter; the important point is to obtain the correct intensity.

The examination of these and other problems forms part of the programme of fundamental research on radiant heating now being carried out by the Joint Research Committee of the Gas Research Board and the University of Leeds. The work involves the study of the emission characteristics of sources of radiant heat, together with the examination of the reflection and absorption properties of a wide variety of materials which offer possibilities of, or are already being, processed by radiant heat.

The equipment for this fundamental work includes an infra-red spectrometer, while practical tests on a larger scale are being carried out in co-operation with the Yorkshire Industrial Gas Development Centre, using a gas-heated radiant tube unit installed in the Fuel Department of the University.

There can be no question but that gas-heated appliances are very suitable as sources of radiant heat in a considerable number of existing applications. The main object of the fundamental research work is to establish the principles of the radiant heating process so that, with the necessary knowledge of the characteristics of both the radiant source and the material being heated, the process can be operated at maximum efficiency in each and every specific application. Special attention is also being paid to the possibility of improving the design and performance of gas-heated sources, as well as their application in new fields.

The **President** said that Yorkshire scientists were well aware of the valuable research work which had been carried out by Dr. Roberts, and therefore they were enabled to visualize a very wide field of application for the future utilization of gas. They were even looking further afield than paint drying, because the amount of fuel used in this country for heating and drying processes in low-temperature ranges represented a very big potential load for the Gas Industry. They all wished Dr. Roberts success in his further experiments.

Vote of Thanks

Mr. **C. H. Bamber** (Rochdale), in proposing a vote of thanks to the lecturers, said that all the members of the Association would leave the Lecture Room with a clearer idea of the importance of the work which was being carried out both at Leeds and by the Gas Research Board. The speakers had devoted themselves mainly to industrial gas research. In his own town, said Mr. Bamber, approximately 35% of the gas produced was used for industrial purposes. This was a relatively high figure, though not so high as in the case of some other localities. Therefore he was intensely interested in the idea of using permeable refractories for what amounted really to the recovery of waste heat, and he was quite prepared to reconsider many of his ideas concerning industrial furnaces. The use of permeable refractories for waste heat recovery was a very considerable step forwards towards achieving 100% efficiency with a gas-fired furnace.

Mr. **G. E. Currier** (Bradford) seconded the vote. The Addresses which had been delivered caused him to think that we were not merely living in a democratic country, but that gas production was in its turn becoming a democratic industry. Dr. Hollings had invited criticisms and suggestions from the rank and file of members, but before complying with the request perhaps it would be advisable to arrive at a fuller understanding of the results which had been already achieved. They were indebted to Mr. Gunn for the clarity of his explanation of the permeable lined furnace. Many such furnaces were operating in Yorkshire districts, and probably the Lancashire members would think it worth while to study their operation. Dr. Roberts had said much concerning the infra-red rays and radiant heating. This was not a new idea to the Gas Industry, but it was incumbent upon them all to exploit it to the full.

Dr. **Hollings** responded.

A further vote of thanks was accorded Professor Townend and his staff.

Visits were paid to various laboratories and other departments of the University.

A C.W.G. Plant in Scotland

During the winter of 1941–1942 the need to augment the gas production plant in a Scottish Gas-Works became somewhat acute, and after consideration of the immediate requirements and post-war possibilities, it was decided to install a carburetted water gas plant. Following upon a careful study and the inspection of several plants, a contract was placed with Davison & Partner, Ltd., in collaboration with their parent company, the Power-Gas Corporation, Ltd. The plant supplied has capacity to produce 500,000 cu.ft. of blue water gas daily with the gas due to carburetting in addition. The design is a development of the firm's U.S.A. associates, the Semet-Solvay Engineering Corporation (pioneers in the back run process), and is the proved and reliable outcome of considerable experience in the reconstruction of many existing sets as well as the building of a great number of new installations. The following description has been sent to us by Messrs. Davison & Partner.

The plant is of the back run type, and embodies the latest development of ignition dome chequerless carburettor with opposed oil injection. The brickwork at the top of the carburettor incorporates specially designed baffles and nozzle which control the flow of gas from the generator down the centre of the vessel. A water cooled oil injector is located near the base of the carburettor, and oil is sprayed upwards countercurrent to or against the downward flow of blue water gas from the generator. The oil particles therefore pass continuously into a new atmosphere of gas at progressively increasing temperature until completely gasified. Due to the absence of chequer-bricks in the carburettor, the gas passes at a low velocity and therefore the time of contact is longer. This ensures proper cracking and an intimate mixing of the blue water gas with the oil vapours.

The baffles in the carburettor also create a turbulence of the blow gases from the generator and a proper mixing with secondary air which enters at the top of the vessel. A proportioning device is fitted in the secondary air supply to regulate and vary the amount of air entering the carburettor. As the CO content of the blow gases leaving the generator increases from start to end of the blowing period, so the amount of secondary air is gradually increased by direct mechanical control. This ensures proper combustion and therefore full use of the potential heat in the blow gases, and the carburettor is not cooled by excess air at the beginning of the blow.

The oil injection system is arranged so that a heavy steam purge is automatically brought into operation immediately following the closing of the oil control valve. This clears the oil line and the injector of oil, so preventing "dribbling" at the injector and the consequent choking of the spray with carbon. During all periods when oil is not being injected, a light steam purge (3 to 5 lb. per sq. in.) is maintained through the injector to keep the spray clean. These features are a valuable aid to maximum oil efficiency.

In the superheater, a firebrick arch and tiles are provided at a point about 5 ft. from the base to support all chequerbricks above this point. A manhole below these arches affords access to renew the lower tiers of chequers which are the first to become foul through carbon deposition, without disturbing the main body of brickwork in the vessel. The chequerbricks are of an improved design with no flat surfaces on which dust can accumulate. There are alternate square pedestals and baffled recesses on both upper and lower surfaces, the square pedestals acting as supports for the succeeding tier of bricks so that only the baffled recesses are in contact with the gases. Staggered formation results automatically when laying the bricks and provides a zig-zag path for the gases, giving longer travel and greater contact area.

Insulating bricks are used on all vertical annular walls of the main vessels, thereby eliminating the hot spots which characteristically accompany the use of loose packing materials and which have a detrimental effect on steelwork.

The anti-glare equipment which has been developed and installed with success on many plants to conform with blackout restrictions consists of a firebrick-lined vessel so designed that a certain time contact is maintained between the waste blow gases and water which is sprayed into the vessel during the blowing period only. The water valve is controlled by the operation of the generator primary air or blast valve. The downward and tangential entry of the blow gases into the base of the anti-glare chamber makes this an efficient grit-catcher. A drain and grit pipe is laid from the bottom of this chamber into a water-sealed sump at ground level.

The generator, carburettor, and superheater shells have coned tops, which is a stronger construction and provides better ventilation and facilities for cleaning and painting than the usual flat top. On the generator shell a side ash door is fitted; this is more accessible than

bottom ash door, makes for greater solidity through having the bottom plate in one piece, is located at a convenient height for easy removal of ashes, and has a renewable asbestos joint. The difficulty is thereby avoided of maintaining tight a metal-to-metal faced bottom ash door which is awkwardly accessible in an ash pit and is often the source of leakage of fumes which cause corrosion of the bottom plate.

The condenser is of the vertical tubular high velocity four-pass type with connexions arranged for contra-flow of gas and water.

The automatic mechnical operator is of particular interest in that it entirely disposes of the need for constant attendance. Left to itself, it controls all of the valve operations, each successive cycle being a repetition of the previous one in duration of blow, up-run, back-run, purge, &c. If any change in duration or sequence is necessary, this can easily be arranged by simple adjustment to the setting of the cams. Should any untoward circumstances cause a valve to operate in a dangerous sequence, gas-making operations are at once stopped by the emergency shutdown equipment, which also brings an alarm into operation that continued to sound until stopped by hand. The plant attendant can, if he wishes, very simply cut out the control portion of the apparatus, while retaining the means it provides for moving the plant valves. If the motive power entirely fails, the different control valves can be manually operated. The sequence of safety interlocks is maintained during manual operation of these valves.

The operator is installed in the machinery house, where the atmosphere is much cleaner than in the generator house proper. This ensures a minimum of wear and tear, and at the same time brings all machinery under the observation of the plant attendant. The instrument panel and all control points are also located within the machinery house.

Dilution in Gas Manufacture

By J. W. GIBSON

A LIFETIME experience in the design and putting into operation of plants for the dilution of straight coal gas, and experience gained in the design of the "Simplex" water gas plant first described in the "GAS JOURNAL" in December, 1919, and later in the issue of March 2, 1921, form the background of the present article.

The original Simplex plant was designed to accommodate the needs of small and medium-sized undertakings, as prior to that date no plant other than that employing a relief holder had been in general use, and an attempt was made and proved successful in practice to couple the plant direct into the foul main and so obviate the necessity for auxiliary plant. Plants erected as far back as 1921 are still in satisfactory operation, producing some 90 therms per ton of coal used, and by simple arrangement of additional units larger makes can be met, the various units then being worked independently or together, thus enabling the plant to meet the needs of larger undertakings.

Tests made on the plants in question show the necessity for chemical analysis of the gases as a guide to design and working. In producer gas plant practice a general guide as to the correct saturation temperature is afforded by the analysis of the resultant gas. If the CO_2 content is too high, then the saturation temperature is probably too high. On the other hand, if the hydrogen content is too low the saturation temperature is again too low.

In my initial experiments with the Simplex plant, steam, air, and gas pressure, temperature of gas, &c., received consideration and various adjustments were made, use being made of constant complete analysis of the gas. (Incidentally, I think this was the first plant to operate under "no-pressure" conditions in the generator; in fact, a slight vacuum was employed. The following is an analysis of the gas carried out by Messrs. Alex. Wright & Co., Ltd., Westminster:

	Before Adjustments.		*After Adjustments.*
CO_2	8.2	.	4.9
O_2	0.6	.	0.2
Unsaturated hydrocarbons		.	0.4
CO	34.1	.	48.0
CH_4	1.3	.	7.5
H_2	50.8	.	33.7
N_2	5.0	.	5.3

Computed calorific value, 283 B.Th.U., 340 B.Th.U. respectively.

These features were confirmed after further adjustments to depth of ash and fuel bed, saturation temperature, &c. on the producer gas plants had been made.

	Before Adjustments.		*After Adjustments.*
CO_2	6.2	.	5.1
O_2	1.0	.	—
CO	22.6	.	27.3
CH_4	1.9	.	1.0
H_2	15.7	.	17.0
N_2	52.6	.	49.6
Combustibles, 40.2%		.	45.3
Computed calorific value 141 B.Th.U.		.	151 B.Th.U.

In the design of plants for dilution purposes consideration has been specially given to the need of fuel economy, bearing in mind that good gas coal will be in short supply in the years to come. Greater fuel economies can be effected by the use of a plant manufacturing gas of a low inert content than, say, producer gas of a 50% inert content. The following basic figures have been taken into consideration.

Output of 20 *million cu.ft. per diem.*

Make per ton of coal of 14,000 *cu.ft., or* 63 *therms.*

Average calorific value of gas supplied of 450 *B.Th.U.*

Straight Coal Gas, coal used, 1,429 tons.

Mixture of 25% *Producer Gas.*

15,000,000 cu.ft. of 560 B.Th.U. (coal gas), 11,000 cu.ft. per ton of coal used.

5,000,000 *cu.ft. of* 120 *B.Th.U.* (*producer gas*).

20,000,000 cu.ft. of 450 B.Th.U. gas coal used = 14,600 cu.ft. or 65.7 therms per ton of coal used. . 1,364 tons

Coal used, old conditions . . . . 1,429 „

„ „ with 25% mixture producer gas . 1,364 „

Saving . . . . 65 tons per annum.

Mixture of 40% *Blue Water Gas.*

12,000,000 cu.ft. of 560 B.Th.U. (coal gas) 11,000 cu.ft. per ton of coal used.

8,000,000 *cu.ft. of* 290 *B.Th.U.* (*blue water gas*).

20,000,000 cu.ft. of 452 B.Th.U. gas coal used = 18,300 cu.ft. or 82.3 therms per ton of coal used. . 1,090 tons

Coal used, old conditions . . . . 1,429 „

„ „ with 40% mixture blue water gas . 1,090 „

Saving . . . . 339 tons per annum.

Operation of the Plants

No attention is necessary other than the cleaning of the fires and charging. By the special design of the firebar arrangement, clinkering troubles are practically eliminated. The plants are automatically controlled by operators of novel design.

A small vertical steam engine designed for long and continuous running is coupled direct to and drives a timing gear which actuates power cylinders. This automatic operating gear reduces labour costs to a minimum and runs silently without ratchets, pawls, cams, springs, &c., that give trouble and need attention. The new temperature control automatic operator has been evolved on the principle that temperature conditions proved by experiments are essential to efficient gas production.

The new design acts as follows: When the vessels, generator, carburettor, superheater, &c., reach the predetermined temperature for efficient gas production, indication of this is communicated by thermocouple located in the gas outlet or other source to a recording controller (which also indicates the temperature prevailing). This controller is arranged with cam type contacts which control an electro-hydraulic thrustor or thrustors connected to a line shaft which operates the isolating valves and puts the plant in action—or out of action when the temperature of the vessels falls below a figure where the manufacture of gas is no longer an economic proposition and the generator requires heating up again.

The requirements for this type of control are few and simple:

1 Iron-constantan thermocouple.

1 Single point recording and regulating potentiometer fitted with two cam type contacts and necessary relays complete with charts which would record the cycles effected by the plant.

1 Box panel to accommodate this recorder and other gauges as required.

Signal lamps incorporated in the panel which operate as follows:

BLUE—continuously when thermocouple is active.

GREEN—Right temperature of make period.

RED—When temperature is no longer of the right degree for the efficient production of gas.

This panel, if necessary, can be located in the engineer's office, enabling the working of the plant to be under visual observation at any time.

This temperature control apparatus has many uses, an example being the ability to control blast fan conditions and establish a definite air/gas ratio in the plant.

The intermittent type of plant (Patent No. 10086) is rectangular, brick lined, with a mild steel outer casing. The output capacity of each unit can be arranged to suit local conditions, but for small works a margin is allowed for by seal regulation and alternative steaming inlets. Units are designed for an output capacity of 20,000 cu.ft. up to 75,000 cu.ft. per diem.

LARGE-SCALE APPARATUS FOR THE COOKING AND SERVING OF FOOD

General view in the Principal Kitchen of a large Canteen Installation by

MAIN

R. & A. MAIN LIMITED, LONDON & FALKIRK

The following factors have been taken into consideration:

From fuel of good reactivity, with a minimum amount of fines—
A consumption of 35 lb. of fuel for each 1,000 cu.ft. of gas produced.
" " 45 lb. of steam " " "
" " 2,500 cu.ft. of free air for each 1,000 cu.ft. of gas produced.

With tar enrichment, consumption of 25 gall. per 50,000 cu.ft. of s produced. (50% of this tar is recovered and saleable as semi-hydrated tar.)

A relief holder is not required. The outlet from the plant is coupled rect to the foul main. A special feature of the plant is that a pilot pe is taken from the generator, which allows of a quick pick-up of e exhauster to deal with increased load.

For producer gas manufacture the generator is filled with fuel, the ack valve is opened, the gas offtake valve closed, the blast fan started raise fuel to the requisite temperature (about 500°C.), steam admitted r about two minutes (purge), and then the gas offtake valve is opened, ack valve closed, and steam adjusted to saturation temperature to it the fuel in use. The plant then runs automatically. The output n be arranged by blast pressure in action (for 1,000 cu.ft. per hour, neral average 4 in.) or seal regulation in hydraulic main.

For blue water gas manufacture the generator is filled with fuel to predetermined level. The blast, steam, stack, and gas offtake lves are arranged for a cycle of five minutes blow and ten minutes n. Plants should be pricked up and cleaned and charged every ur hours.

For enriched water gas the process is as with blue water gas manu-cture. During the last five minutes of run the operating valve is ened and steam enrichment vapours are admitted to the carburettor, hen the hot ascending gases from the generator will meet the tarry pours in a contrawise direction with light oils freed. Permanent xing of the enrichment hydrocarbons is effected by the gradual oling of the gases as they pass along the foul main to the condensing, ashing, and purification plant.

The continuous plant (Patent No. 10,087) has been designed to romote conditions whereby constant quantity and quality of the gas n be secured. Flexibility as to output is governed by—

1. Arrangements whereby steam can be admitted at different levels in the generator for increasing or decreasing the area of fuel bed to be steamed.
2. Arrangements whereby the seal can be adjusted in the wash box (hydraulic main) to regulate quantity control.
3. By employment of twin generators arranged in parallel (each separate and distinct from each other) whereby the output of gas is continuous—*i.e.*, one generator on blow period while the other is on run period.

By these arrangements any desired quantity of gas can be produced om the plant on an economic basis. The units are separate and istinct from each other. In the case of closing one unit down for utine overhaul, the other unit could be utilized for production.

Plant capacities vary from 50,000 to 500,000 cu.ft. per diem. Con-itions are well suited for the operation of a waste heat boiler.

The following instruments are provided mounted on a suitable anel: dry dead-beat pressure or vacuum gauge (gas), blast pressure auge, steam pressure gauge, dial thermometer (saturation tempera-ure), and pyrometer.

The following are the approximate values of the gas made:

Producer gas . . .	120–150 B.Th.U. gross per cu.ft.
" " (enriched) .	120–200 " " "
Blue water gas . .	280–300 " " "
" " (enriched)	320–360 " " "

The approximate fuel consumption for 1,000 cu.ft. of gas produced :

Coke .	35–40 lb.
Steam .	45–60 lb. (depending whether blast fan is steam driven).

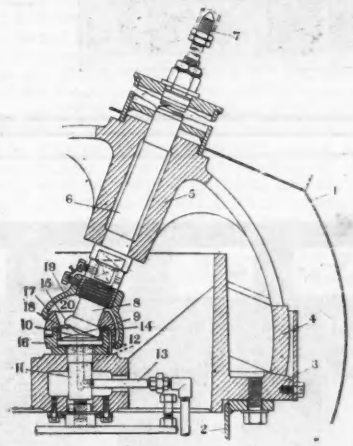
Salient Features of the Plants

1. Can be used by the smallest of undertakings.
2. Greater margin of flexibility as producer gas, blue water gas, and .W. gas can be manufactured in the same plant.
3. Cheap method of enrichment, utilizing own product tar (50% esidue recovered as semi-dehydrated tar); as an alternative oil could e used.
4. Generator constructed of 9 in. standard firebricks (with no pecials), thus less costly renewals and maintenance charges.
5. No expensive chequer brickworks required for carburettor by he method of filling employed.
6. New form of firebar in generator, making for a greater gassing rea of fuel bed (bars can be replaced while plant is in operation).
7. Gas offtake valves ensure maximum production of gas from the lants (no seal in hydraulic main).
8. Standard section of hydraulic main employed which not only cts as a wash box for removal of dust from gases, but ensures a reater degree of control of production under all conditions.
9. Dual blast to generator provided for more equal distribution of air over fuel bed.
10. Steam inlets to plant for gasification arranged at different levels for production of alternative gases.
11. Provision made for water cooling of firebars (no burnt-out firebars) and less clinker troubles.
12. Method of superheating steam.

Wet Gas Meters

W. C. Holmes & Co., Ltd., C. Ingham, and D. M. Henshaw have been granted a patent (No. 561,116) relating to wet gas meters of the type in which there is arranged to extend into a body of a sealing liquid a bell to which a tumbling or swashplate motion is given by the gas passing through the meter. In a previous specification (No. 512,447) the patentees claimed a wet gas meter of this kind, in which the bell is provided internally with a rolling ring co-operating with a stationary track formed on or secured to a gas inlet pipe coaxially with the opening of which there is arranged a member provided with a bearing for a spherical surface on the lower end of the spindle of the bell. The spindle is provided adjacent to the spherical surface with an annular rolling surface which co-operates with a stationary track on the member provided with the bearing for the spherical surface. The object of the present patent is to provide a meter of the kind in which the bearings are more effective in carrying the loads and resisting the stresses to which they are subjected.

In the drawing, 1 is one of the walls of the bell dividing it into a plurality of compartments, 2 is the gas inlet pipe about which is located a stationary tract 3 with which co-operates a rolling ring 4 provided on a member 5 secured to the spindle 6, the upper end 7 of which is connected in known manner with an indicating device in the form of a counter which records the number of revolutions the spindle and bell make.



On the end of the spindle 6 there is arranged a member 8 provided with a conoidal surface 9 co-operating with a second conoidal surface of the seating 10 formed on the member 11 which is furnished with a passage 12 through which may be passed oil by way of the pipe 13.

Formed about the seating is located a ring 14 provided internally with a spherical surface co-operating with a spherical surface 15 on the member 6, the ring being secured in position between the elements 16 and 17 which form a chamber 18, which, becoming filled with oil, functions as an oil bath for the conoidal and spherical bearing surfaces.

On the spindle 6 there is secured a cap 19 provided with a surface 20 which will co-operate with the external spherical surface of the elements 16 and 17, and will function as a cover for the bearing surfaces and in preventing the spindle 6 being withdrawn while the bell is inclined in its normal position, but on the other hand will enable, when the spindle is in an approximately vertical position, the bell and its associated bearing parts to be withdrawn from the chamber 18 and re-entered into the chamber without fitting or adjustment.

The construction enables the shank of the spindle of the bell to be made of greater diameter than the shank of the spindle of the previously known constructions and in fact of a diameter equal to that of the main portion of the spindle, thus reducing the effect of the alternation in the direction of the stresses on the spindle and thus the meter is capable of considerable overloads. Further, the disposition of the bearing surface withstanding the radial thrust enables this area to be increased, and the surface is disposed equidistant on each side of the line of force. The design enables the area of the conical rolling surface carrying the dead weight of the drum to be increased in length or width.

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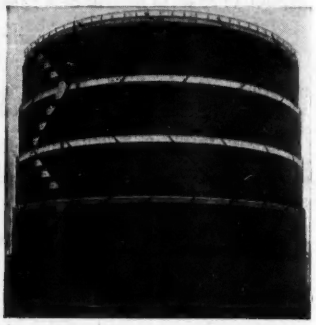

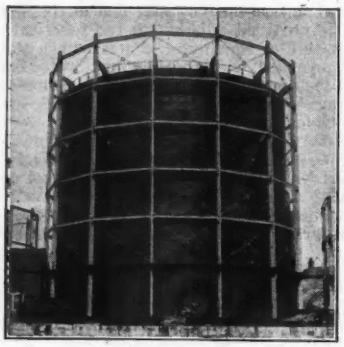

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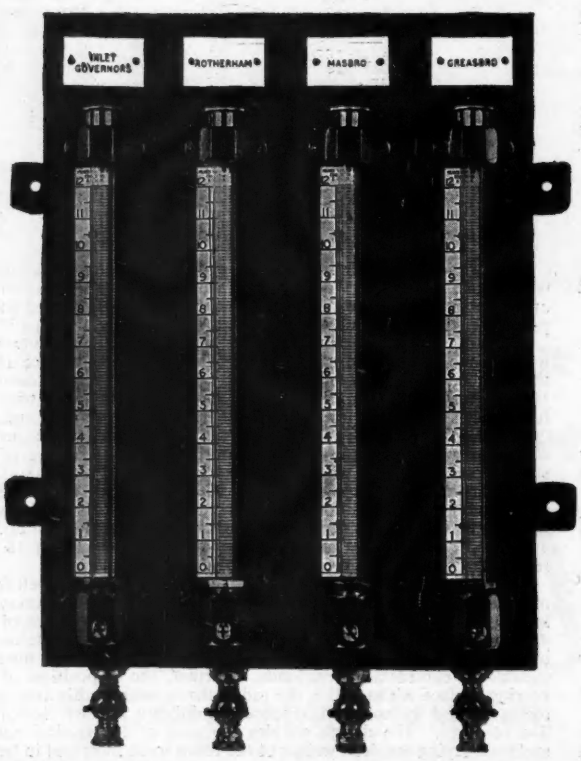

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Simplified Meter Bodies

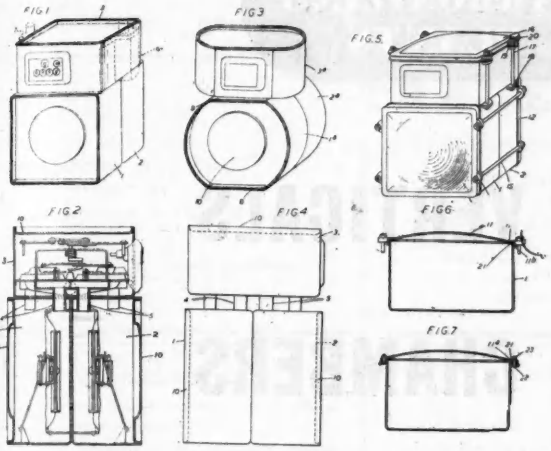
Simplified construction of gas meter bodies is the object of patent pecification No. 562,096, granted to J. H. Bingham. Another object to protect such bodies from the deleterious effects of impurities equently contained in the gas passing through gas meters and nereby increase their effective life.

According to the specification a gas meter body is in part built up om two open-mouthed box-like structures assembled back to back; third open-mouthed box-like structure is assembled with its base n or immediately above two aligned faces of the first-mentioned tructures.

A diaphragm may be assembled in each of the first two structures nd valve grids may be assembled in the other structure, and each tructure is adapted to be closed and sealed by an end closure. The everal structures may be united by spot welding, bolts, screws, or ny convenient means, and the third structure may be connected to nd spaced from the first two structures by gas conduits. The inner urfaces of each structure are protected by a coating of vitreous or like namel.

Fig. 1 is a perspective view of a gas meter constructed according o the invention; fig. 2 is a sectional elevation thereof; figs. 3 and 4 llustrate alternative constructions of gas meters; fig. 5 illustrates one nethod of fixing end closure members; figs. 6 and 7 are detail views.

In one method of carrying the invention into effect shown in fig. 1 and two substantially identical open-mouthed rectangular boxes, 1, 2,



preferably of metal, are assembled back to back—that is, with the faces of their bases in contact. These boxes may be made by pressing, spinning, or by any suitable means and are preferably of sheet metal. They may, however, be cast, and in this event may be of synthetic resin. They are united along their contacting faces in any desired manner. If the boxes are of metal they may be spot welded. Alternatively they may be joined by rivets, bolts, or screws.

If now the contacting faces are disposed in a vertical plane, a third open-mouthed rectangular box 3 is assembled with its base parallel and in contact with the two upper horizontal faces of the first two assembled boxes. The base of the third box is preferably of substantially the same size and shape as that of the surface presented by the two upper horizontal faces.

In the interior of the box 3 valve grids of normal construction are assembled as indicated in fig. 2, and one of these grids communicates by means of conduits 4 with the interior of the box 1, and the other grid communicates by means of conduits 5 with the interior of box 2. Inside the boxes 1 and 2 the usual diaphragms are assembled. The conduits 4 and 5 may be utilized for securing the box 3 to the boxes 1 and 2 and/or the boxes may be connected by spot welding, bolts, rivets, or any other means. Gas inlets and outlets indicated at 6 and 7 are provided in accordance with known practice.

In lieu of using rectangular boxes, substantially cylindrical boxes with opposed flattened sides may be employed in place of the boxes 1 and 2. This construction is shown in fig. 3, in which box 1*a* replaces box 1 and box 2*a* replaces box 2 of figs. 1 and 2. The flat sides 8 constitute a base for the meter, and on the other parallel flat sides 9 is assembled a substantially oval-shaped box 3*a* corresponding to the box 3 of fig. 1, which has a flat base resting upon the flat sides 9. The grids are assembled within the box 3*a*, and the grids communicate by conduits in manner described with the interior of the boxes 1*a* and 2*a* in which are assembled the diaphragms.

The arrangement shown in fig. 4 is substantially identical with that shown in fig. 1, excepting that the box 3 is maintained in spaced relationship with the boxes 1 and 2 by means of the conduits 4 and 5, which function to connect box 3 to boxes 1 and 2 and act as spacers.

In the constructions shown in figs. 1, 2, 3, and 4, the end closure members, generally indicated at 10, for all of the boxes, are of dished configuration, and are let into the open mouth of each box and are there secured by spot welding or by solder, or they may be secured by any other convenient means; it is an essential consideration that the joints between the end closures and the boxes are gas-tight. In lieu of using dished end closures, end closures of the type indicated in figs. 5, 6, and 7 may be employed.

In fig. 5 the end closure 11 for box 1 and the end closure 12 for box 2 are formed with lugs 13 transfixed by bolts 15. A leather or other sealing washer is positioned between the open mouth of the boxes and the inner periphery of the end closures so that as the bolts are tightened up by means of the nuts shown, the boxes are securely sealed and are rendered gastight. The end closure 16 for the box 3 is secured by means of bolts 17 transfixing lugs 18, 19, and 20, lugs 18 extending from the base of the member 3, lugs 19 being positioned at or near the upper end of the box 3 and lugs 20 being positioned on the end closure 16. A suitable sealing ring of leather or the like is positioned between the outer ends of the box and the internal periphery of the end closure, so that as the bolts are tightened up the end closure is securely fixed in position and a gas-tight joint is made. The end closures 11, 12, and 16 may be domed or dished, if desired.

Fig. 6 is a diagrammatic sectional view illustrating one method in which the end closure seals the box. The box, for example 1, has a sealing ring of leather or the like 21 positioned around its open mouth, and the end closure 11 bears down on this sealing ring to effect a gas-tight joint. The end closure is shown dished, but it is plane around its periphery as indicated at 11*a* to ensure that an effective seal is made with the sealing ring 21. For further protection and to obtain a better sealing effect the end closure may be formed with a flange 11*b*, which may, if desired, terminate in an out-turned bead as shown.

In an alternative construction shown in fig. 7 the arrangement is the same as in fig. 6 with the exception that the box has an out-turned flange 22, on which rests the sealing ring 21, and such ring is gripped between the flange 22 and the plane part 11*a* of the end closure. In this type of construction the plane part 11*a* may be secured to the flange by bolts and nuts indicated at 23.

According to customary practice gas meter bodies are built up from pieces of tin plate joined by soldering. This is a comparatively tedious process calling for the employment of skilled or semi-skilled labour. Furthermore, after the body is built up it obviously cannot be coated with vitreous enamel for the reason that the solder joints would melt during the stoving process. The patentee claims that by the present invention these disadvantages are overcome. The three open box-like structures can be mass produced by unskilled labour and can be assembled by unskilled labour, and prior to being assembled or subsequent to being assembled they can be vitreous enamelled. If dished end closures of the type illustrated in figs. 1, 2, 3, and 4 are used, such end closures may be secured in position by spot welding or soldering and conveniently sealed by solder, and the inner periphery or peripheral face of the box-like structures contacting with the flanges of the dished end closures are preferably kept free from enamel to facilitate the fixing and sealing of the end closures, but if end closures of the type illustrated in figs. 5, 6, and 7 are employed the whole of the box-like structures can be coated with enamel. Similarly, if end closures as illustrated in figs. 1, 2, 3, and 4 are employed these may be vitreous enamelled, but are preferably not vitreous enamelled on the flanges. If, however, the end closures are of the type illustrated in figs. 5, 6, and 7 they may be vitreous enamelled all over. If desired the diaphragm mountings and other metallic internal parts of the meter may also be vitreous enamelled. The term "vitreous enamel" includes only an enamel formed or applied under the application of heat. The surface of meters or meter bodies in accordance with this invention may if desired be protected by means other than vitreous enamel, such as cold setting enamel, paint, or plastics.

A Standard Colour Scheme for Gas Industry Vehicles

Following a suggestion from one of the Districts that a standardized colour scheme for gas transport vehicles might be adopted throughout the country, the British Commercial Gas Association is promoting a Competition whereby members of the public are invited to submit suggestions for a suitable colour scheme.

Prizes of National Savings Certificates, worth in all a total of £52 10s., are offered by the B.C.G.A. for the best suggestions submitted. Gas undertakings may wish to supplement these by offering an additional prize or prizes for winning entries from their district, or for the best local entries.

The Design and Industries Association has agreed to judge the entries, and has nominated a panel of three of its members for this purpose.

Publicity material to enable the undertaking to participate in the Competition consists of the following items:

(1) A leaflet giving the Conditions of Entry.
(2) A suggestion for a typeset local advertisement.
(3) An editorial paragraph for insertion in local newspapers.
(4) A double-crown poster in colour announcing the Competition.

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GAS PRODUCTS PRICES

The London Market Sept. 4.

A Government Order came into effect on March 1 controlling the price of Benzole and Coal Spirit and replacing the Control of Coal Tar Naphtha and Xylole Order, 1943.

The Order is known as the Control of Benzole and Coal Spirit Order, 1944 (S.R. & O. 1944, No. 172).

By this Order the price of Motor Benzole is fixed at 2s. per gallon. The Order also lays down the method of evaluating Crude Benzole.

The Order also calls for periodical returns to the Ministry of Fuel and Power from all producers of Crude and Refined Benzole.

The only item of interest in connexion with the Coal Tar products market is the issue of Government Order designated the Control of Toluene (No. 4) Order, 1944 (S. R. & O. 1944, No. 170), which contains an amendment of the Control of Toluene (No. 3) Order, 1943.

Attention is called to a new Government Order, which amends the price of Toluene as from September 1, 1944. The Order is entitled, The Control of Benzole and Coal Spirit (No. 2) Order, 1944 (S. R. & O., No. 988).

Apart from this there are no changes in the prices of Coal Tar Products.

The Provinces Sept. 4.

The average prices of gas-works products during the week were: Pitch and Crude Tar,* Toluole, naked, North, 90's, 1s. 11d. to 2s. 1d., pure, 2s. 7½d. (controlled by the Control of Toluene No. 3 Order, dated July 14, 1943, operative from July 20, 1943). Benzole and Coal Spirit, also Coal Tar Naphtha and Xylole, are now controlled by the Control of Benzole and Coal Spirit Order, 1944, dated Feb. 18, 1944, S. R. & O. 1944, No. 172, operative from March 1. Carbolic acid, 60's, naphthalene, anthracene, creosote oil (hydrogenation), coal tar oils (timber preservation, &c.), and strained anthracene oil controlled by the Coal Tar Products Prices Order, 1943, dated Oct. 20, 1943 (S. R. & O. 1943, No. 1528), operative from Nov. 15, 1943.

* In regard to pitch and crude tar prices we would ask readers to refer to the editorial note on p. 396 of the "JOURNAL" for Sept. 10, 1941.

Scotland Sept. 2.

Market is unchanged with deliveries proceeding smoothly. Refined tar*: Yield to distillers is 4½d. per gallon *ex* Works, naked. Creosote oil: Timber preserving quality,* 5½d. to 6½d.; hydrogenation oil,* 5⅞d.; low gravity or virgin oil,† 7½d. to 7¾d.; benzole absorbing oil,* 6½d. to 8d. per gallon. Refined cresylic acid* is 3s. 6d. to 4s. 6d. per gallon *ex* Works, naked, according to quality. Crude naphtha†: 6½d. to 7d. per gallon. Solvent naphtha*: Basic prices delivered in bulk, 90/160 grade, 2s. 8d., and 90/190 Heavy naphtha, Unrectified, 1s. 10½d.; Rectified, 2s. 2d. per gallon. Pyridine†: 90/160 grade, 13s., and 90/140 grade, 15s. per gallon.

* Price controlled. †Uncontrolled.

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